# Comments on "Flexural behavior of concrete slabs with corroded bars"

Goitseone Malumbela *, Mark Alexander, Pilate Moyo

A B S T R A C T

This paper presents a discussion on a paper authored by Chung et al. [Chung L, Najm H, Balaguru P. Flexural behaviour of concrete slabs with corroded bars. Cement Concr Compos 2008;30:184-93].

*Keywords:*
Pitting corrosion
Diameter loss
Faraday's law
Moment capacity

## 1. Discussion

The authors of [8] attempted to relate experimental results on reduction of flexural strength of reinforced concrete slabs due to varying degrees of corrosion of reinforcing steel bars and bond length with an analytical model. The work by the authors is very important for characterization of structural performance of corrosion damaged reinforced concrete structures. There are however some expressions and equations used by the authors that are questionable.

1. In modelling residual strength after the corrosion process, the authors used a theoretical mass loss from Faraday's law and they reference [4,11] as having reported an excellent correlation between actual mass loss and theoretical mass loss calculated using Faraday's Law. In contrast, according to [5,9] it is necessary to determine actual mass loss after the corrosion process as Faraday's Law underestimates actual mass loss for degrees of corrosion below 5% and overestimates mass loss for degrees of corrosion above 10%. To show a lack of confidence in Faraday's Law, other researchers such as [3] have developed other models to associate loss in bar diameter due to corrosion.
2. The authors of [8] re-express Faraday's Law to directly calculate percentage loss in bar diameter. Following work by [13] however, equation used by the authors to calculate the percentage loss in bar diameter is incorrect. Consequently, other equations developed by the authors of [8] that use the percentage loss in bar diameter such as the equation for flexural strength are equally incorrect.
3. The authors mention in the paper that with time, pitting corrosion extends over the bar resulting in relatively uniform corrosion. In contrast, other researchers such as [2] found that pitting corrosion is highest at high degrees of corrosion than at low degrees of corrosion.
4. The equation for ultimate moment capacity used by the authors follows a linear bending theory of stress–strain curve of concrete in compression. In contrast various design codes such as [1,6,7,14] as well as other researchers such as [10,12] use a non-linear bending theory to define the stress–strain relationship of concrete in compression.

## References

[1] ACI Committee 318. Building requirements for structural concrete (ACI 318-2005) and commentary (318R-05). American Concrete Institute, Farmington Hills, Michigan; 2005.
[2] Almusallam AA. Effect of degree of corrosion on the properties of reinforcing steel bars. Construct Build Mater 2001;15:361–8.
[3] Andrade C, Alonso C. Cover cracking as a function of bar corrosion: Part 1 – Experimental test. Mater Struct 1993;26:453–64.
[4] Auyeung Y, Balaguru P, Chung L. Influence of corrosion on the bond behaviour of reinforcement bars. ACI SP 2000;193:1051–74.
[5] Badawi M, Soudki K. Control of corrosion-induced damage in reinforced concrete beams using carbon fiber-reinforced polymer laminates. J Compos Construct 2005;9(2):18–194.
[6] BS8110-1:1997, Structural use of concrete. Code of practice for design and construction.
[7] CEB-FIP Model code, Comite Euro-International Du Beton; 1990.
[8] Chung L, Najm H, Balaguru P. Flexural behaviour of concrete slabs with corroded bars. Cement Concr Compos 2008;30:184–93.
[9] El Maaddawy T, Chahrour A, Soudki K. Effect of fibre-reinforced polymer wraps on corrosion activity and concrete cracking in chloride-contaminated concrete cylinders. J Compos Construct 2006;10(2):139–47.

[10] El Maaddawy T, Soudki K, Topper T. Analytical model to predict nonlinear flexural behaviour of corroded reinforced concrete beams. ACI Struct J 2005;102(4):550–9.

[11] El Maaddawy T, Soudki K. Effectiveness of impressed current technique to simulate corrosion of steel reinforcement in concrete. J Mater Civil Eng 2003;15(1):41–7.

[12] El-Tawil S, Ogunc C, Okeil A, Shahawy M. Static and fatigue analysis of RC beams strengthened with CFRP laminates. J Compos Construct 2001;5(4):258–67.

[13] Malumbela G. Comments on model for cover cracking due to corrosion expansion and uniform stresses at infinity. Appl Math Model, in press.

[14] South African National Standards, Structural use of concrete-Part 1: design (SANS 10100-1:1992)", Pretoria: The Bureau; 1992.